

## ***A Case for Circadian Lighting in Federal Buildings***

It's 5 a.m. on a cold winter morning. The wind is howling, a few clouds are swirling overhead, and a day's old snow is covering the grass. Having just finished packing his lunch, Jimmy Smith grabs his work bag and walks to his car to begin his long, dark commute to work in the big city. Jimmy works in a federal building and will drive his car 20 minutes to a commuter station where he will then board a train that will take him the remaining 45 minutes into town. Once



Jimmy arrives in the city, often before sunrise, his usual routine takes him to a local coffee shop where he orders a triple espresso, the first of three trips to the coffee shop he'll make that day. Jimmy next walks the three blocks to his office where he climbs four flights of stairs and walks down a narrow, dimly-lit hallway to his cubicle to start his day.

By 11:00 a.m., Jimmy is exhausted and has to get another caffeine jolt so he can remain alert to continue his workday. On most days, Jimmy will leave his cubicle to go home around 4:30 p.m. and will arrive back home around 6:00 p.m. During the winter, he rarely sees the sun as he leaves for work and returns from work when it is dark outside.

What is missing in Jimmy's daily routine? The presence of light! While this story may sound like the beginning of a fiction novel, it is the current reality of a lot of people working in office buildings. Health and lighting researchers, interior designers, building owners, even the federal government have started to invest more resources into studying the connections between light and the health of people working inside buildings. The nexus of light and health is a topic of conversation that is growing by the day, and it is something that anyone who works indoors should better understand. But let's start at the beginning.



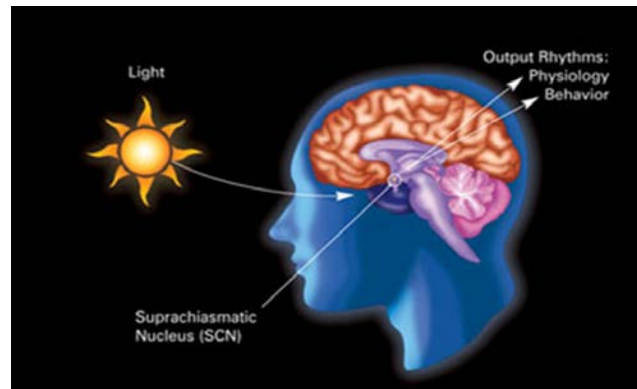
### **Connection between light and health**

Light has three basic functions, all of which have different pathways in the brain: the first is light for vision so a person can see; the second is light to convey information such as a traffic light indicating red to stop and green to go. The third function of light is to maintain the body's

circadian system to the solar day so that the wake/sleep cycle is in synch with natural cycles. While the first two functions are very important, it is this third function of light that many believe has the greatest benefit to people's health and well-being through impacts on the body's circadian rhythms.

A person's "body clock" is regulated by circadian rhythms, which are physiological processes that occur approximately every 24-hours. These 24-hour rhythms have also been widely observed in plants, animals, fungi, and even bacteria. An example of a circadian rhythm is your wake/sleep cycle. Depending on many external factors, you will typically wake up when it is light and go to sleep when it is dark each day. Cognitive functioning is also another example of something driven by the circadian system. You may be able to do highly complex tasks such as mathematics in the morning, but have more difficulty later in the day and at night when you are less alert. Light, especially daylight, has an alerting effect. You are not the same person in the morning as in the evening.

No matter whether from the sun or from a man-made source, light enters the eye and travels up the optic nerve to a portion of the brain called the suprachiasmatic nucleus where it evokes a biological response. That response can be both physical and behavioral. A function of light is to entrain the body's circadian system to the solar day so that the wake/sleep cycle is in synch with natural light/dark patterns on Earth. If your circadian rhythm is entrained, you sleep well at night and are alert during the day. On the contrary, if you do not receive adequate circadian stimulus, you are more likely to experience poor sleep quality and be sleepier during the day.



### *Absence of Light: A Cause for Concern*

The biological systems that underlie much of human behavior evolved in a natural world where people lived and worked outdoors during the day and sat around the campfire sharing stories at night. The industrial revolution forever changed all of this, and humans moved indoors to work, live, and play - away from daylight. The advancement of electric lighting in the 20th century provided widespread access to light at any time of the day, which further removed people from needing to harness daylight in their daily lives.

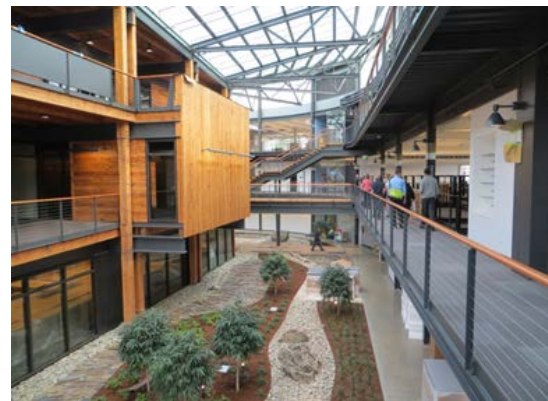


As seen with Jimmy Smith, sometimes people go to work and leave from work in the dark. As a consequence, when do people see the light? Well,

it happens at work. A study from the Harvard School of Public Health concluded that people spend over 90% of their time indoors<sup>1</sup>, and the vast majority of people's waking hours are in the office. Numerous health studies have found correlations between circadian rhythm disruption and chronic disease and health problems such as poor sleep, higher stress, heart disease, diabetes, and even higher incidences of breast cancer. People are starting to take notice; so much so that this topic has been brought to the mainstream through green building conferences, interior design forums, even Ted Talks. People are talking about it, but what is actually being done?

### *GSA Research on Circadian Light*

The shift from being outside all the time to being inside most of the time presents both a public health concern and a call to action. It is precisely why the U.S. General Services Administration (GSA), the nation's largest public real estate organization, became interested in circadian light. GSA has a diverse portfolio of almost 8800 assets housing a federal workforce of 1.1 million people and over 400 different agencies, bureaus and commissions. This constitutes a little less than 380 million rentable square feet of space split between government-owned and leased properties.



With such a stock of buildings, GSA has an opportunity to optimize the luminous environment within its buildings to improve the health and well-being of its tenants. GSA has been working to improve buildings from the occupant's perspective for a long time. For instance, GSA prohibited smoking in its buildings and near building entrances and intakes long before this was law.



Although there is a large body of research on light for vision, much less is known about the building occupants' experience of light and how it influences circadian functioning. GSA and researchers from the Lighting Research Center (LRC) from Rensselaer Polytechnic Institute are filling this knowledge gap by studying the connections between light and the health and well-being of people in buildings.

### *Study Sites in 5 GSA Buildings*

GSA and the LRC have conducted research at five GSA buildings across the country:

<sup>1</sup> J. Spengler, Harvard School of Public Health, 1983



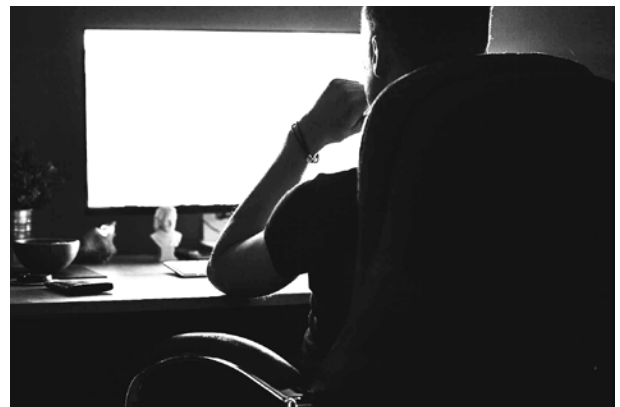
- Edith Green-Wendell Wyatt Federal Building in Portland, Oregon
- Federal Center South Building 1202 in Seattle, Washington
- GSA Headquarters building in Washington, D.C.
- GSA National Capital Region Regional Office Building in Washington, D.C.
- Wayne N. Aspinall Federal Building and U.S. Courthouse in Grand Junction, Colorado

The research took place at each building both in the winter and summer to account for seasonal variability in the length of days and the sun angle.

#### What GSA is Learning from the Research?

While GSA and the LRC are continuing to collect data, several preliminary findings support the case for more circadian light in buildings.

1. **People get more circadian light while at work than anywhere else.** In GSA's research, circadian light at work improved some measures of sleep and mood and promoted more activity during the daytime hours and less activity during the nighttime hours. Circadian light also helped participants fall asleep more quickly at night and spend more time asleep and less time tossing and turning while in bed. This provides an opportunity to influence the circadian functioning of building occupants while they are at work. Based on previous research and available literature, the best time for circadian entrainment is in the morning.
2. **More circadian stimulus during the day in winter (*may*) means better sleep, less depression and more positive moods - but not necessarily in summer.** The benefits of circadian light at work are greater in the winter than in the summer. In the winter, research participants spent less time awake at night and slept more efficiently. A possible explanation for why these findings did not occur in the summer is that people may be receiving too much light late in the day because they are more active after work when the sun is still up. As a result, the increased exposure to daylight disrupts the person's circadian entrainment and potentially causes sleep problems and sleepiness the next day during work. Further research is needed to confirm this; however, winter may be the best time to influence circadian functioning of building occupants.
3. **In many instances, daylighting alone is insufficient for entraining people's circadian functioning in the workplace.** The research team found pockets of biological darkness in every building it studied, due to shade use, workstation





layouts, and many other factors. This suggests that daylight should be supplemented by electric light solutions for circadian stimulus in more dimly lit spaces.

4. **Computers are a key factor in lower circadian stimulation.** Workspaces are typically designed around where the computer sits on the desk. In addition, computers are key driver of shade use and other daylight reducing behaviors. Glare and other challenges occur when building orientation, light reflecting off of adjacent buildings, and placement of overhead lights are not taken into consideration during workspace design.
5. **Designing the interior of the workspace is an interdisciplinary problem-set.** Design for circadian stimulus should be an exercise involving multiple stakeholders, including the end-user (customer), prior to finalizing decisions.

The last preliminary finding above confirms that circadian lighting is an ecosystem of three distinct parts: Daylight design including windows, controls, and how both are integrated with electric lighting technologies; interior design including the type of furniture in the workspace, layout, colors, finishes, computer ergonomics; and the organizational system of the entity in the workspace including the workplace culture, occupant behavior, nature of work, reward structure, and work technologies used in the space. All of these parts have an impact on the circadian stimulus potential of occupants in the workspace, and suggest systems thinking and cross-collaboration between stakeholders must occur. While this can be accomplished more easily during workspace renovations, how do we optimize the luminous environment in workspaces that are not being renovated? While a challenge, this is not impossible, and GSA is beginning to explore various best practices that it can promote to its employees and tenants for people to get the necessary circadian entrainment whether through behavioral modification, workspace patterns, or through the use of market-available technologies that can mimic daylight in workspaces with no access to daylight.



It's time to bring circadian light into buildings to promote the health and well-being of the people working in them! Access to circadian light is a right and should be something readily available to anyone working in a building. While the science behind circadian light is still growing, the message is getting clearer by the day: get light - mostly daylight - morning best!